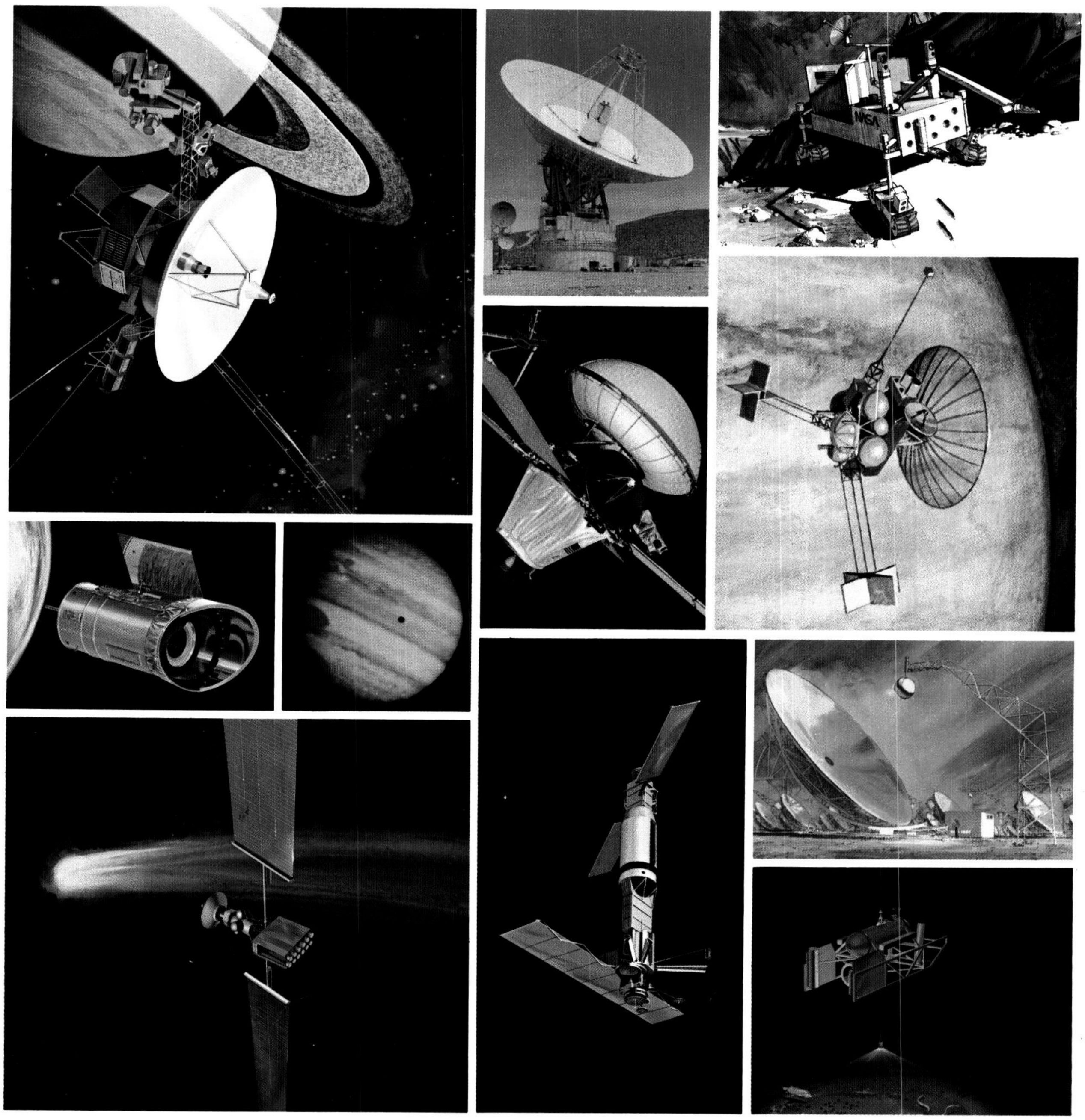
JPL PROFILE



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JPL PROFILE

The American space age began on January 31, 1958, with the launch of the first U.S. satellite, JPL's Explorer 1. The prime discovery of Explorer 1 was the Van Allen radiation belts that surround the earth. The 14-kilogram (31-pound) spacecraft continued transmitting until May 23, 1958, and reentered the atmosphere on March 31, 1970.

JPL was chosen for the nation's first space venture because of the Laboratory's expertise in rocket propulsion that began in the mid-30s. Almost every rocket that flies today shares the common heritage of pioneering research at JPL by the late Professor Theodore von Karman of the California Institute of Technology and several graduate students, who, according to one of them did "rather odd experiments in a desolate spot in the Arroyo Seco north of Pasadena." That desolate spot is now the site of JPL. It covers 165 acres and employs nearly 4000 people.

That early research led to basic discoveries in solid- and liquid-fueled rockets. The first application was in JATO, jet assisted take-off, for aircraft in 1940.

On December 3, 1958, two months after the creation of the National Aeronautics and Space Administration, JPL was transferred from Army jurisdiction to the new civilian agency. The transfer provided for the Laboratory to be operated by Caltech for NASA.

After Explorer 1, JPL led the United States' missions to the moon and the planets. Today JPL's primary responsibility under Caltech's contract with NASA is exploration of the solar system with automatic spacecraft.

The successful Ranger and Surveyor lunar projects, the Mariner missions to Mars, Venus, and Mercury, and most recently the Viking Mars mission are among the Laboratory's significant accomplishments.

On April 1, 1976, Dr. Bruce C. Murray was appointed director of JPL, replacing the retiring Dr. William H. Pickering. Dr. Murray, a geologist and planetologist, has participated as coinvestigator and principal investigator on space-exploration missions managed for NASA by JPL.

The Laboratory's current tasks include participation in the investigation of Mars by Vikings 1 and 2 during their extended mission, exploration of Jupiter and Saturn beginning in 1977, launching an ocean-survey satellite, SEASAT, and tracking and communications for the Jupiter spacecraft Pioneers 10 and 11 and the U.S.–West German Helios Project, now studying interplanetary space near the sun.

Recently, JPL began a new project called SETI, Search for Extraterrestrial Intelligence. Laboratory scientists and engineers are preparing a survey of 80% of the sky, seeking artificial radio signals from extraterrestrial civilizations.

Studies of future missions include a Jupiter Orbiter with atmospheric probe, a mission to return samples of soil from Mars, and a flight to Halley's Comet with either a new spacecraft that sails the solar wind like an interplanetary clipper ship or a spacecraft equipped with ion-drive engines.

Space exploration is coupled at JPL with research and development across a broad spectrum of scientific and engineering disciplines.

Applying technological advances to solving problems on earth is a dedicated effort at JPL. More than 100 tasks are being studied and developed in medical science, pollution, sewage disposal, transportation, and energy.

Other JPL installations include an astronomical observatory at Table Mountain, California, a rocket-test station at Edwards Air Force Base, California, and a launch-operations site at Cape Canaveral, Florida.

To provide spacecraft tracking and communications for deep-space missions, JPL operates the Deep Space Network (DSN) with stations in California, Spain, and Australia. Missions are run from the Laboratory's mission control, the Space Flight Operations Facility. The scientific community also uses DSN facilities for radar and radio-astronomy experiments.

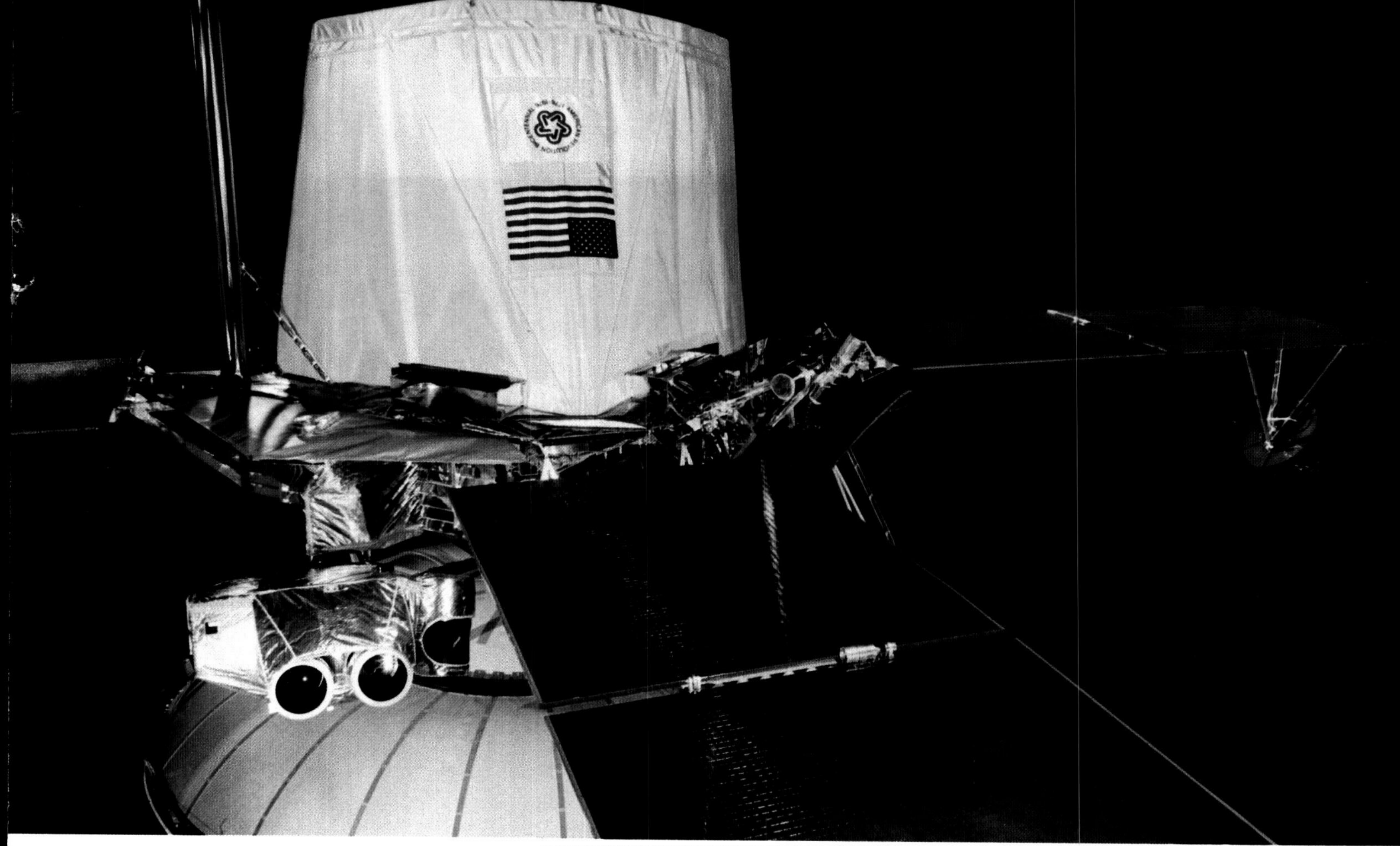
Voyager

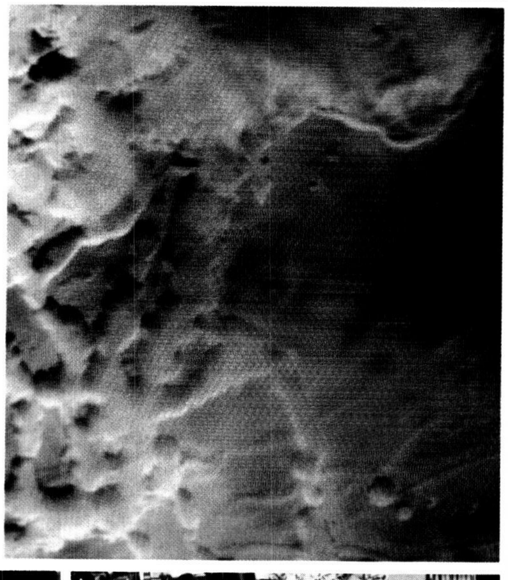
Two Voyager spacecraft, launched in the summer of 1977, are scheduled to fly past Jupiter in 1979 and Saturn in 1980 and 1981.

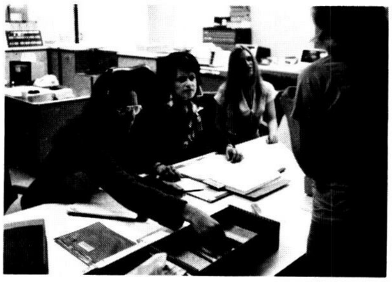
The spacecraft, equipped with television cameras and other scientific instruments, will explore the two planets and their major satellites to obtain information on the environments, atmospheres, surfaces, and internal characteristics of Jupiter and Saturn, and Saturn's fascinating rings.

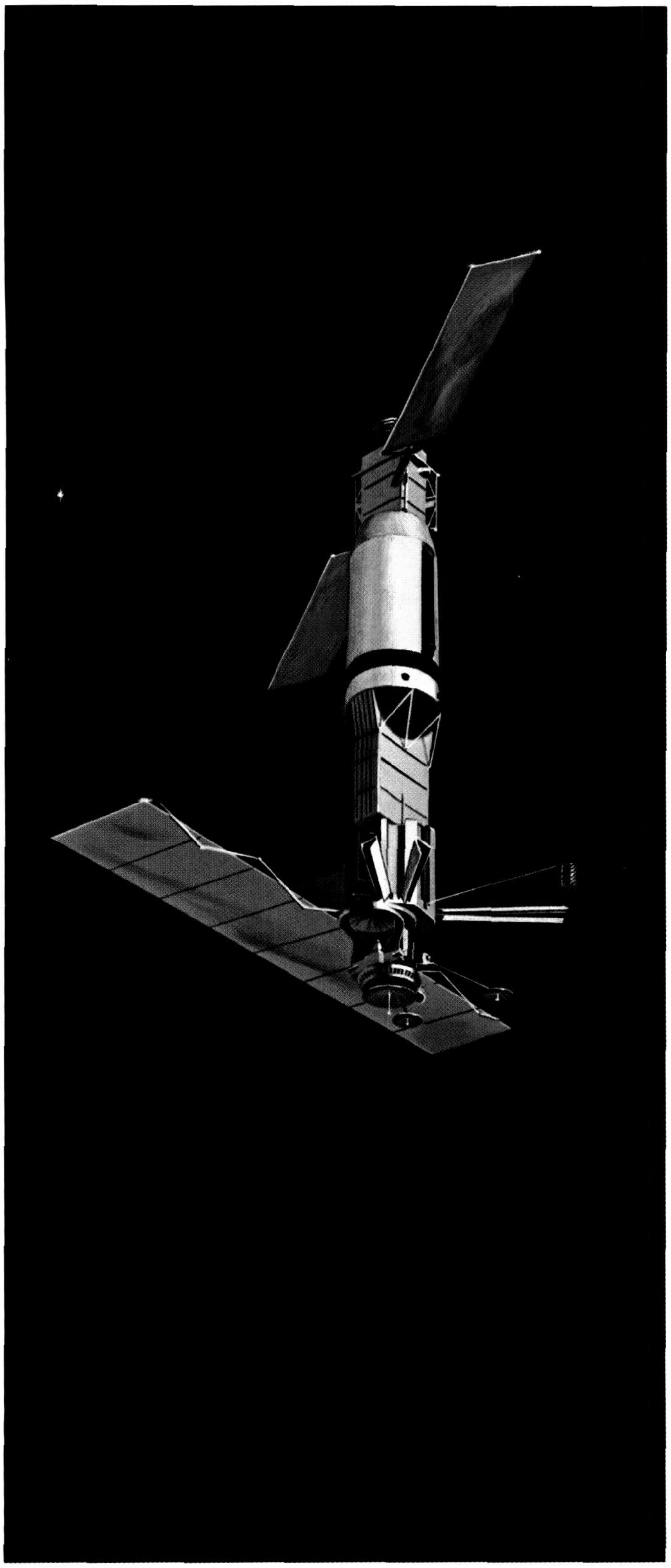
The spacecraft must communicate across vast distances when they reach their targets. At the first Jupiter encounter, Voyager will be 688,150,000 kilometers (427,596,600 miles) from earth. At the second encounter, the distance

Opposite: Voyager spacecraft flies past Saturn after a successful encounter with Jupiter about 2 years earlier. The spacecraft will escape the solar system to wander forever among the stars.









SEASAT

SEASAT is an earth-orbiting satellite designed to survey the oceans of the world. The first satellite will demonstrate to potential users and scientists just what can be learned about the sea from earth orbit.

Eventually SEASAT could become one element of a system to gather, process and distribute information on ice fields, wave heights and lengths, ocean currents, sea temperatures, and storms.

Vast areas of the ocean are seldom visited by man, and are not monitored on a regular basis: great wastes where storms are born, icebergs form and great ocean currents flow unseen. With the launching of SEASAT, those areas will come under daily scrutiny.

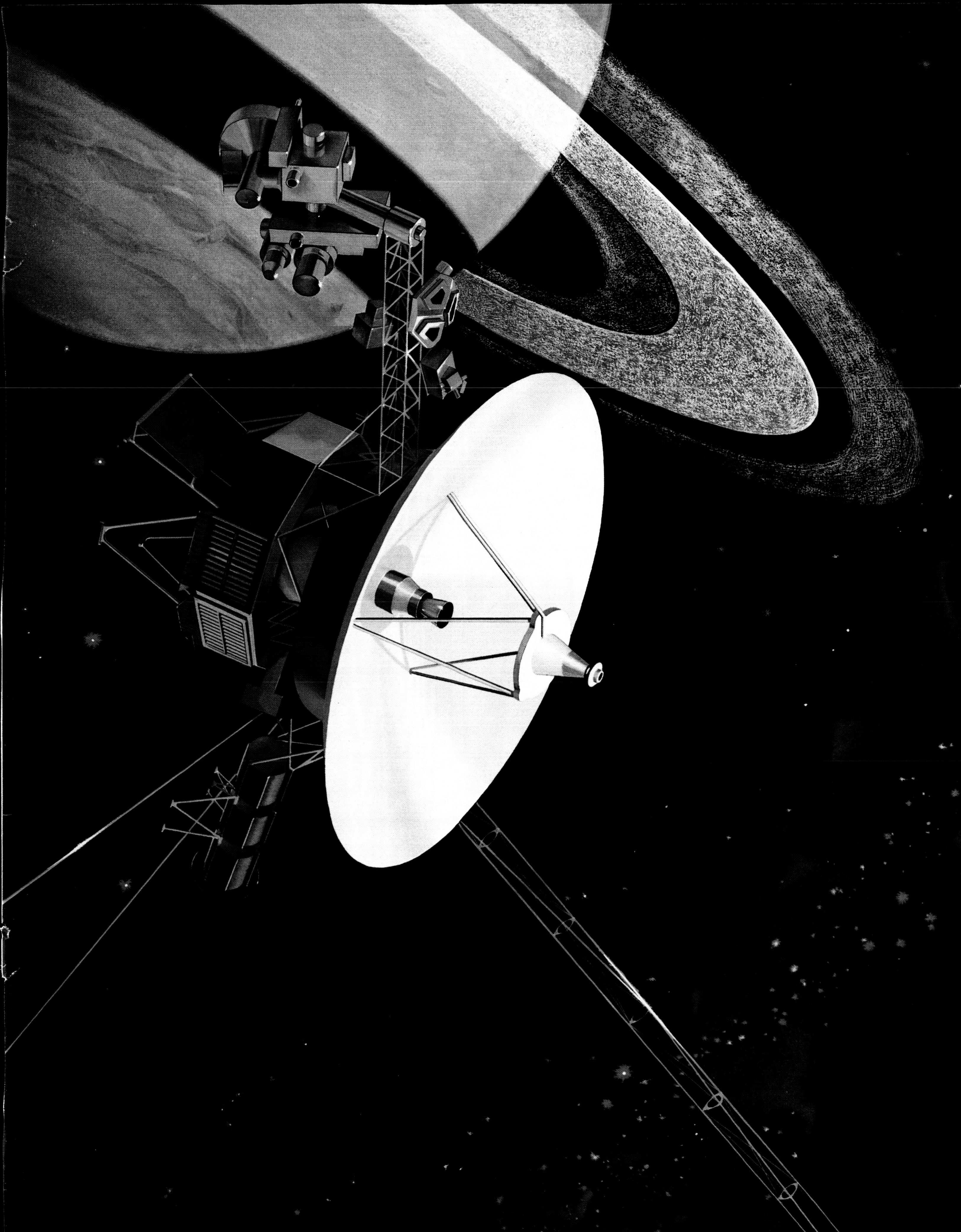
SEASAT's information will be available to a variety of users: oceanographers, shipping firms, weather forecasters, fishermen, offshore oil explorers, the U.S. Coast Guard and U.S. Navy, and other government agencies and industrial firms.

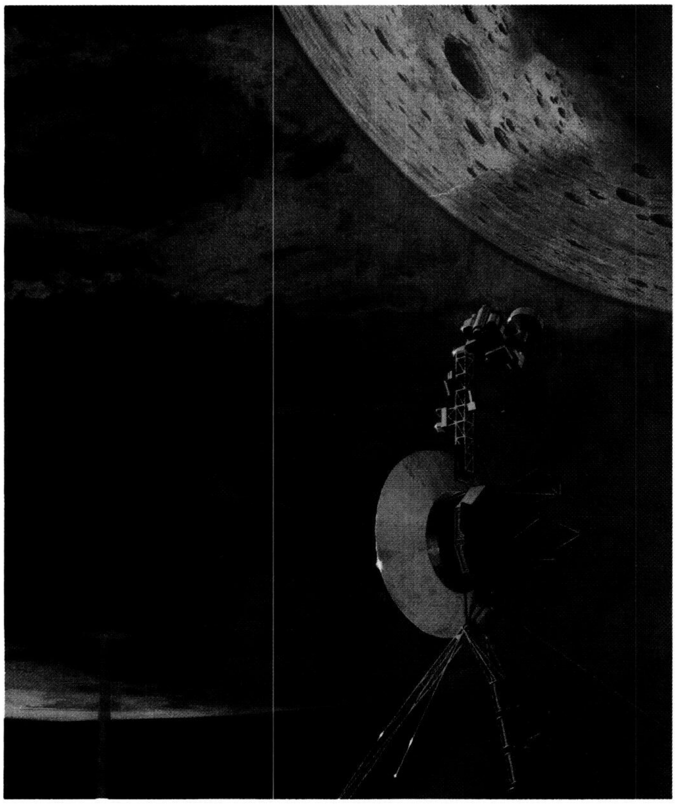
The first SEASAT is an experimental satellite that will attempt to determine whether an operational, multi-spacecraft network to monitor the world's oceans on a continuous basis is worthwhile.

It will be launched into polar orbit in May 1978 and will circle the earth 14 times a day at an altitude of 770 kilometers (480 miles), covering 95 percent of the earth's oceans every 36 hours. If the first SEASAT shows that it can perform the kinds of work scientists hope for, a fleet of four may one day monitor the oceans on an operational day-to-day basis.

Lockheed Missiles and Space Co. is building the first SEASAT. Five sensors on the spacecraft — three types of radar and two radiometers — will measure surface temperatures, wave height, length and direction, ice fields and storms. Other information from SEASAT will be used for studies of geodesy, ocean dynamics, storm dynamics, interactions between ocean and atmosphere, and ocean thermal processes.

SEASAT will obtain wave height measurements to be used in world ocean survey.





As Voyager cruises between Jupiter and its satellite Io, it will take measurements of the "flux tube," a region of high magnetic and plasmatic interaction. In this artist's conception, the flux tube is shown extending in an arc from the surface of Jupiter to Io.

between earth and Jupiter will have grown to 927,506,000 kilometers (576,326,100 miles). At the first Saturn encounter, the distance will be 1,525,898,500 kilometers (948,149,300 miles). When the second Voyager reaches Saturn, it will be 1,555,818,100 kilometers (966,740,500 miles) distant. Because of the vast distances, each spacecraft will be powered by three radioisotope thermoelectric generators (RTGs). The units use plutonium 238.

Each spacecraft consists of a propulsion module — to boost it to the high speed necessary to reach Jupiter and Saturn — and a mission module. The module will separate after the spacecraft is placed on its flight path. Only the mission module, carrying the payload of scientific instruments, will continue the journey to the outer planets. The mission module is an advanced member of the Mariner spacecraft family, modified to survive the long journey and transmit thousands of photographs and other scientific information. It is the most independent and automated spacecraft ever flown.

Viking Mission to Mars

Two Viking spacecraft landed on Mars in the summer of 1976, after an 11-month cruise to the red planet aboard their orbiter companions. The successful landings brought mankind the first pictures ever taken from the surface of Mars. A prime objective of the mission was to search for microscopic life on Mars in man's first attempt to discover life beyond earth.

Viking's objective: as thorough a study of Mars as has been made of any planet besides earth. The Vikings perform 13 detailed and sensitive experiments from orbit and on the surface, including analysis of the planet's atmosphere during descent to the surface. By the end of the primary mission, more than 10,000 pictures had been sent back to earth.

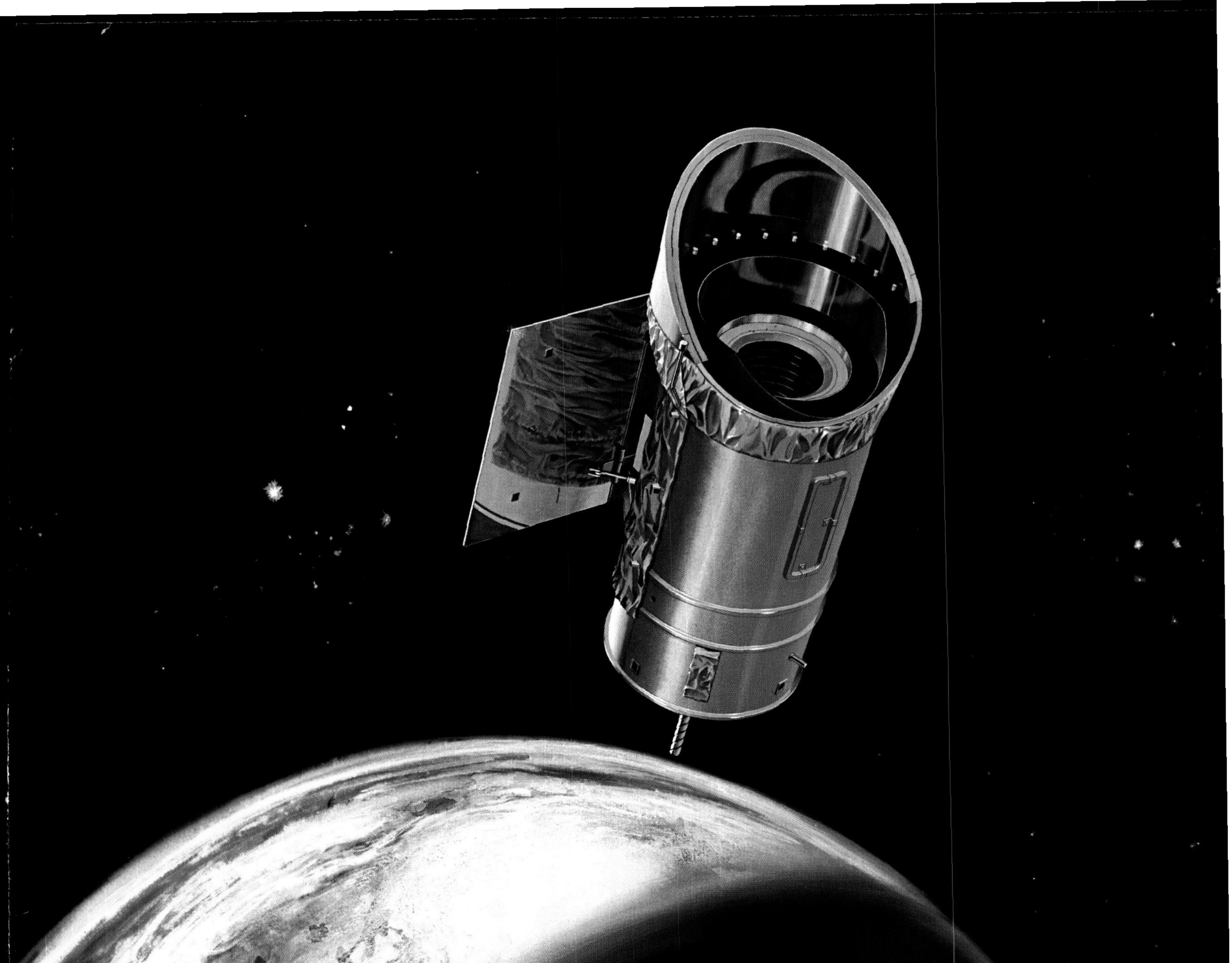
Scientists are getting their first look at the weather on the surface of Mars; they have tested the Martian soil for its mineral makeup and for organic compounds, as well as for microbial life. A seismometer listens for Marsquakes, and a soil sampler digs trenches and shakes bits of soil out of its sieved collector head to study their physical and magnetic properties.

From orbit, Viking measures water vapor in the Martian atmosphere and takes the planet's temperature. Two high-resolution, narrow-angle cameras take thousands of pictures of the amazingly varied surface to help scientists understand some of the strange phenomena they first glimpsed during the flight of Mariner 9 in 1971.

The primary Viking mission ended in November 1976, when Mars went behind the sun as viewed from earth. When the red planet reappeared, the Viking team began an extended mission scheduled to continue through May 1978.

NASA's Langley Research Center has overall management responsibility for the Viking project, and JPL is responsible for building and flying the orbiters, and for operating the Mission Control and Computing Center and the Deep Space Network tracking stations.

Opposite, top: Viking Orbiter with Lander attached — the first spacecraft to perform a successful landing on Mars and search for life there. Center: Image of Noctis Labyrinthis, a portion of the Martian "Grand Canyon," showing ice clouds in and around canyons. Right: Self-portrait of Viking Lander on the Martian surface showing the American flag. Bottom: Viking personnel monitoring mission operations.



IRAS spacecraft mapping the never-before-seen infrared energy sources across the universe.

Infrared Astronomical Satellite

The Infrared Astronomical Satellite (IRAS) is an international project involving the United States, the Netherlands, and the United Kingdom. The project will be jointly managed by JPL and NIVR, the Dutch Space Agency.

The IRAS spacecraft is being designed and built in the Netherlands. The design and fabrication of the large 60-centimeter-aperture telescope will be the responsibility of the Ames Research Center. JPL, in addition to its role as project manager, will design and operate the scientific analysis facility that will produce an infrared sky map and a source catalogue, which may contain up to one million infrared sources.

Launch from the Western Test Range at Vandenberg Air Force Base is scheduled for March 1981. Once in a polar orbit of 900-kilometer altitude, the Explorer-class satellite will be tracked and controlled from a ground station in Chilbolton, England.

Search for Extraterrestrial Intelligence

The Laboratory has undertaken a striking and unusual project — the search for extraterrestrial intelligence (SETI). SETI will conduct a 5-year survey of 80 percent of the sky, searching for evidence of radio signals from intelligent extraterrestrial life. The project is a modest, beginning approach to one of the most profound questions mankind has ever asked: "Are we alone in the universe?"

Project SETI will use two antennas, and advanced microcircuitry and data-processing techniques to survey the sky simultaneously across 1 million frequencies. The 5-year survey is to begin in October 1978, after a 2-year implementation period.

Radio signals come to us from nearly every quarter of space, all apparently of natural origin. The objective of the SETI project will be to sort out and reject those natural signals and man-made radio-frequency interference, and to identify possible artificial signals from a source somewhere in the Milky Way galaxy.

A companion project, using the same antennas, will be undertaken by Ames Research Center. That project will examine 500 selected stars to see if any planets orbiting them might be transmitting signals.

The Deep Space Network

The globe-girdling array of radio antennas and associated equipment called the Deep Space Network (DSN) is managed for NASA by JPL. Antennas at DSN stations in California, Spain, and Australia are continuously tracking and communicating with spacecraft exploring the solar system. They are currently collecting data from Pioneers 10 and 11; Helios 1 and 2; Vikings 1 and 2 (both orbiters and landers); the interplanetary probes Pioneers 6, 7, 8 and 9, and, beginning in 1977, will track the two Voyagers en route to Jupiter and Saturn.

DSN radio-science experiments include radar mapping of planetary surfaces, determining movements in the earth's crust by observing the signals from quasars, and continuing astronomical studies. The DSN will also be involved in the new SETI project.

Pioneer 10 and 11 and Helios

In addition to its own flight projects, the Laboratory provides support to two major programs — Pioneer and Helios — managed by other institutions.

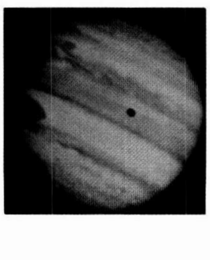
The Pioneer 10 and 11 missions are managed by Ames Research Center; JPL is responsible for spacecraft tracking and data acquisition, and mission control and computing support.

Both Pioneer flights began as missions to Jupiter: Pioneer 10 passed the planet on December 3, 1973, more than 800 million kilometers (500 million miles) from earth, setting a distance record for radio transmission. Since Pioneer 10 is on a flight path that is taking it out of the solar system into galactic space, it breaks the old record daily.

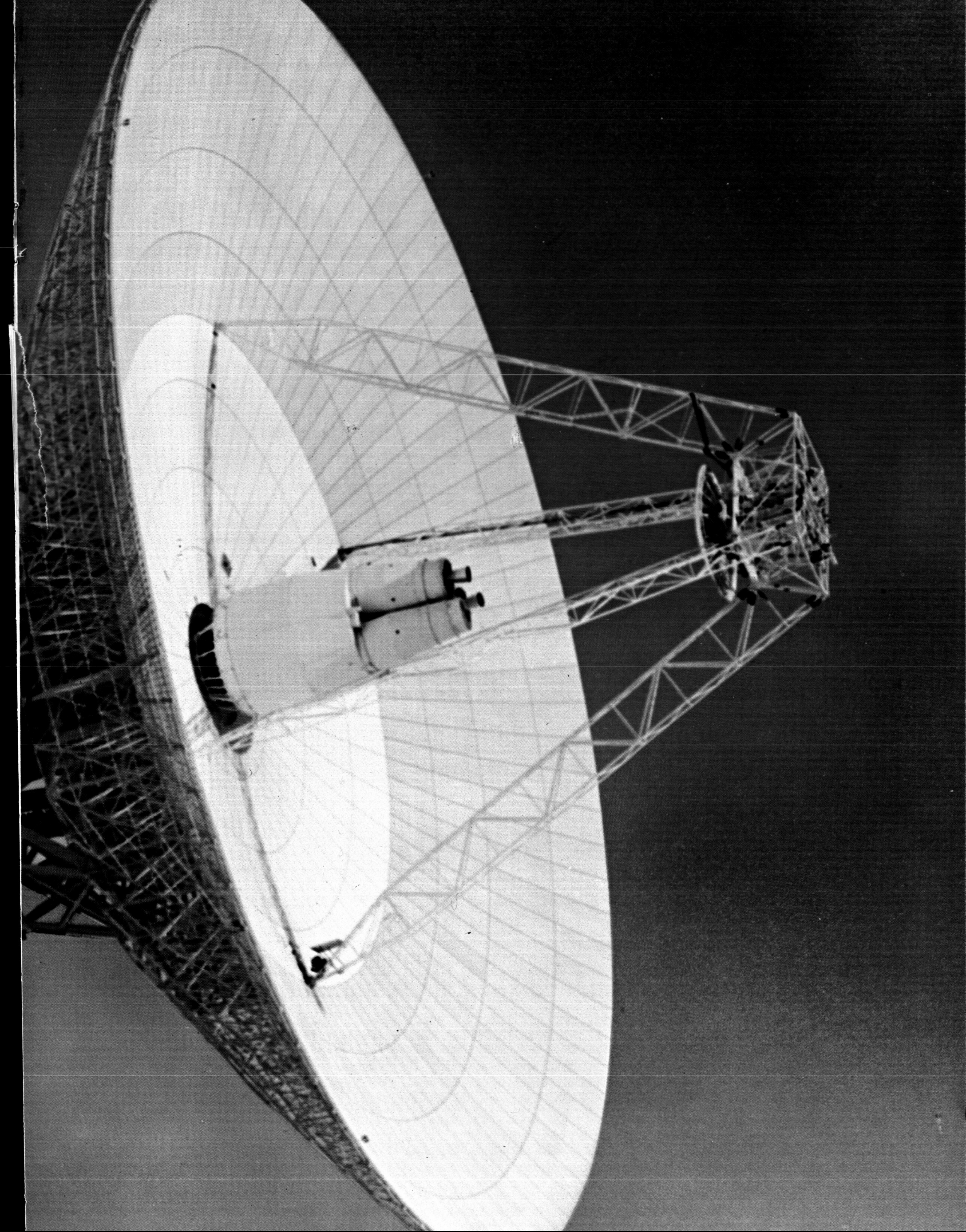
Pioneer 11, launched April 5, 1973, encountered Jupiter on December 3, 1974. Boosted on a new flight path by Jupiter's gravity, the spacecraft is headed toward an encounter with Saturn in September 1979.

The Helios project is a joint U.S.–West German study of the sun, managed by Goddard Space Flight Center and the German Ministry for Research and Technology. Two spacecraft, launched on December 9, 1974, and January 15, 1976, have flown within 43.3 million kilometers (26.9 million miles) of the sun. JPL provided spacecraft technical consulting and testing, and supports the program in tracking and data acquisition, mission control and computing, and technical and operations areas.

The two unmanned Helios spacecraft, encountering temperatures hot enough to melt lead, carrying 10 instruments to investigate the solar wind (ionized particles given off by the sun), magnetic fields, solar and galactic cosmic rays, electromagnetic waves, micrometeoroids, and the zodiacal light.



Left: Photograph of Jupiter taken by Pioneer 10 from a distance of 2,500,000 kilometers shows the planet's Red Spot and shadow of the moon Io. Opposite: Giant reflector of the 64-meter antenna at Goldstone Deep Space Station.



Jupiter Orbiter Probe

A mission to orbit the planet Jupiter and send an instrumented probe into the giant planet's atmosphere is in the planning stages.

The mission, called Jupiter Orbiter Probe (JOP), would be assigned to Caltech's Jet Propulsion Laboratory by NASA's Office of Space Science. JPL would design and build the spacecraft and control the mission; NASA's Ames Research Center would develop the probe.

One JOP spacecraft would be launched by the Space Shuttle in January 1982. Arrival at Jupiter would come 2.9 years later. The long flight time is necessary to allow the atmospheric probe carried aboard the orbiter to enter Jupiter's atmosphere on the sunlit side of the planet. The probe would be separated from the spacecraft 56 days before encounter with Jupiter. It would be aimed at an atmospheric belt — not at the planet's Great Red Spot.

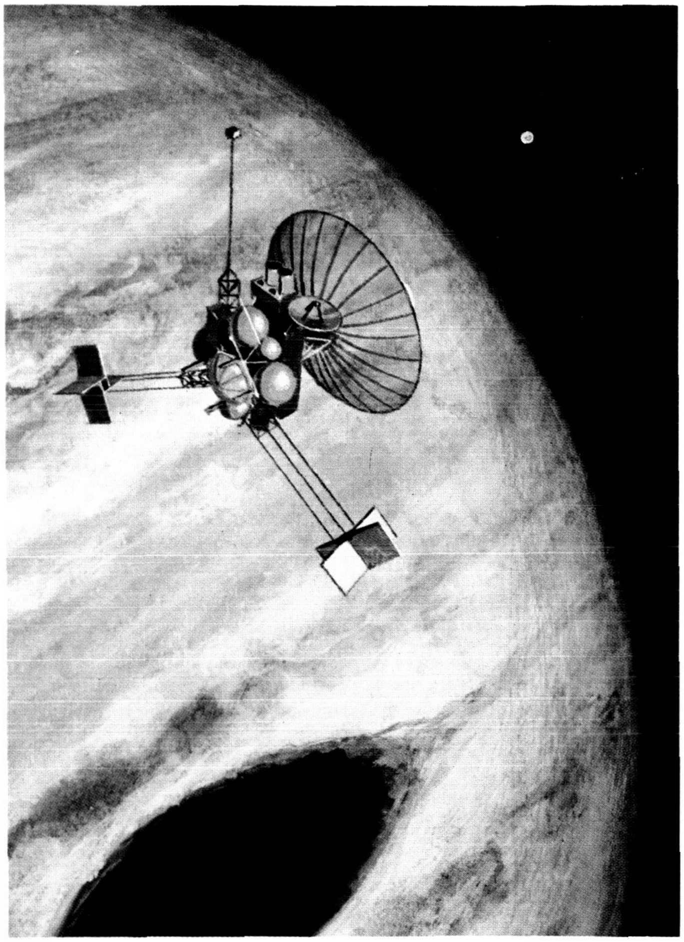
When the orbiter reached a distance of 6 Jupier radii — 426,000 kilometers (264,000 miles) — from the planet, the main engine would burn to slow JOP and let it be captured by Jupiter's gravitational field. Soon after that burn, periapsis (closest approach) would be raised to about the distance of the orbit of Ganymede, third of the Galilean satellites of Jupiter. JOP would remain in that orbit for about 20 months. During that time, it would have several close encounters with the satellites Ganymede and Callisto.

Options for an extended mission include changing the orbit to about that of the satellite Io and raising the inclination, with a goal of 3 years of total orbital operation.

The spacecraft would be a new type, part spin-stabilized and part despun. It would carry a 5-meter (16-foot) furlable antenna similar to those used on the later Applications Technology Satellites.

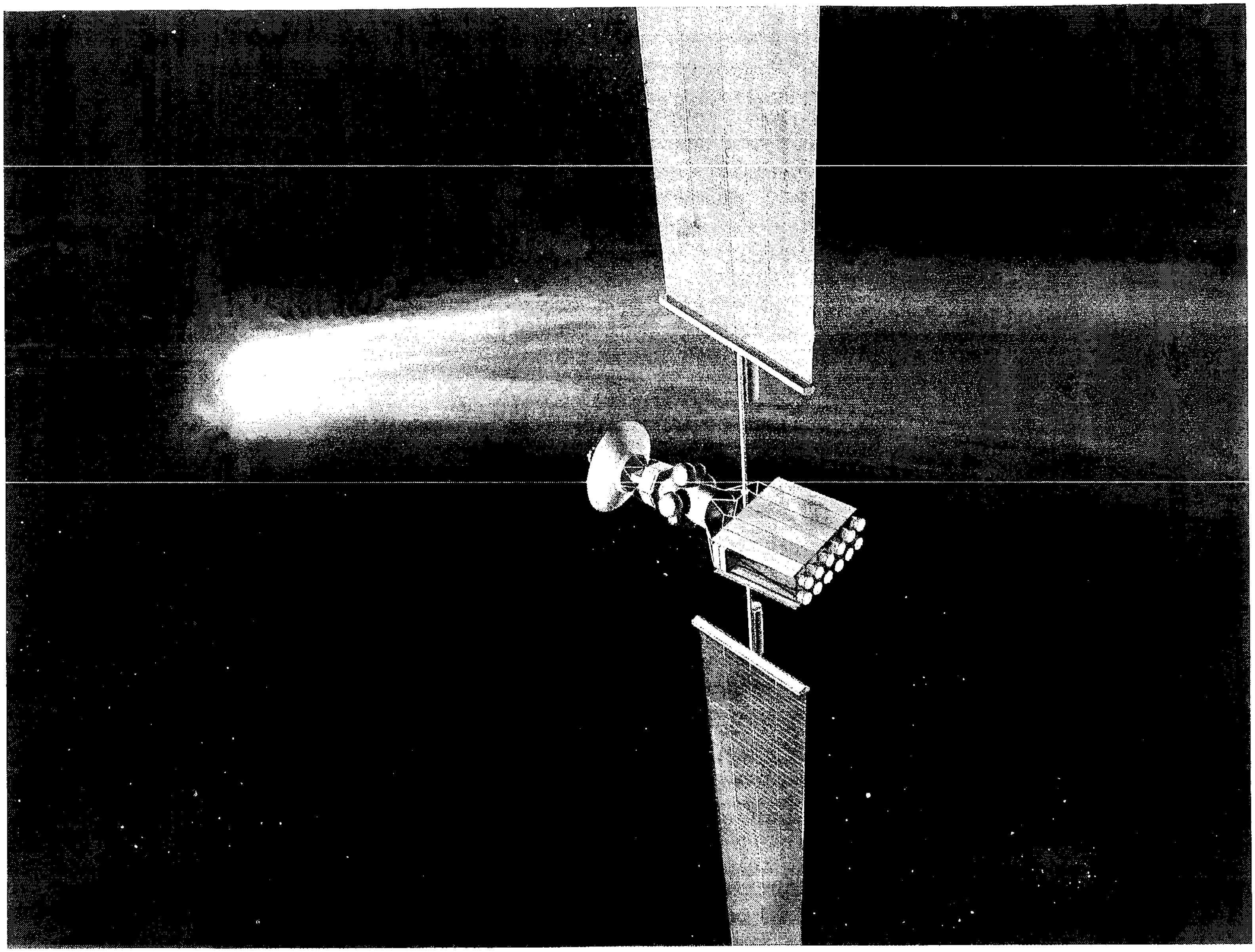
A variety of scientific instruments could be flown aboard JOP, including a new imaging system that makes use of charge-coupled devices (CCDs) rather than the vidicon tubes flown on past Mariner spacecraft. The CCD imaging system would provide a much greater spectral response than previous television cameras. It is expected that encounters with Galilean satellites could yield pictures with resolution on the order of 30 meters (98 feet).

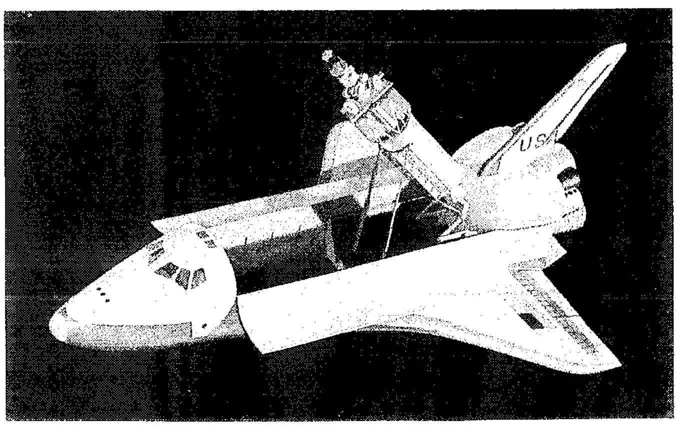
Jupiter and its satellites have been called a ''mini-solar system'' by some scientists because of many similarities between the planet and its satellites, and the sun and planets. One project official refers to the JOP mission as a five-planet encounter. The Galilean satellites, Io, Europa, Ganymede, and Callisto, range in size from larger than the planet Mercury to about as big as earth's moon.



Artist's rendition of JOP. The 20-month mission will investigate Jupiter and make the first measurements of the turbulent atmosphere of the mysterious planet.

A key moment in the flight of JOP -- The red-hot nose cone separates from the probe portion as it samples the atmosphere of the largest planet in the solar system.





Top: Solar electric spacecraft being studied for comet opportunities in the future.
Left: The spacecraft aboard Space Shuttle in preparation for launch.

Solar Electric Spacecraft

A mercury-fueled ion-drive spacecraft is being developed by NASA, with a JPL research team coordinating the efforts of several NASA centers and aerospace laboratories. This spacecraft will be capable of performing the long-term, low-thrust missions being considered for the 1980s.

Huge thin-cell solar arrays would boost electric power as needed on long space flights. A dozen ion engines in tandem could produce over 100 kilowatts of power, aided by two solar cell wings spanning 150 meters (nearly 500 feet), theorists say. Mercury ion engines have been improved steadily through many thousand hours of testing at various NASA centers.

Mars Follow-on

A follow-on mission to Mars, to land two roving vehicles on the surface in 1984, is under study at JPL.

The autonomous rovers could find their way across the Martian terrain, identifying and remembering hazards, while conducting a variety of experiments. The vehicles would be capable of complex operations, with only minimal instructions from earth. Each could cover more than 100 kilometers during the one-Martian-year mission.

The rover would use laser-ranging devices, proximity sensors, stereo cameras, and advanced microcomputers to sense and react to its environment, determining its destination and how to get there safely.

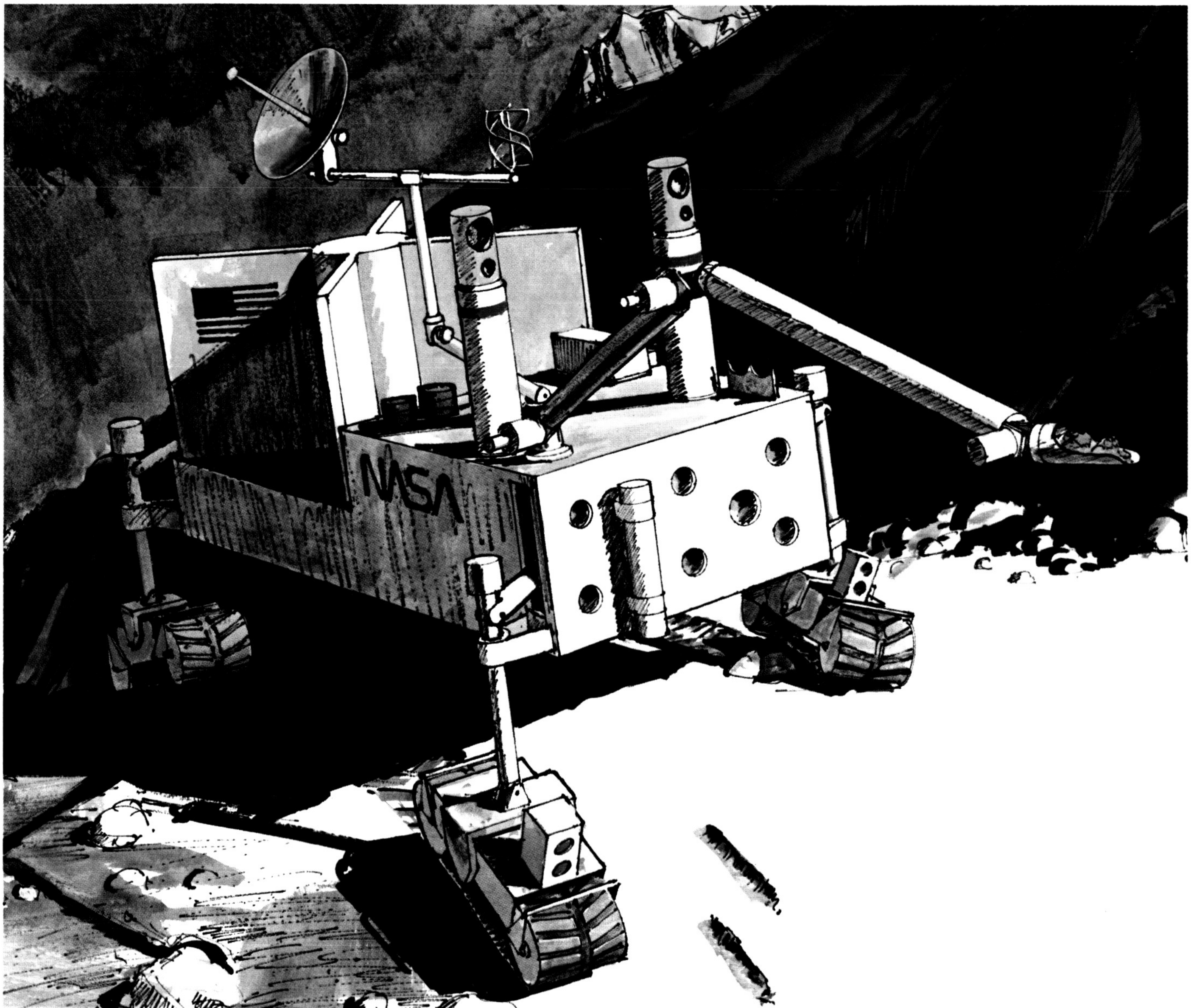
Civil Systems

The JPL Civil Systems effort applies space-derived skills and capabilities to needs of the civil sector with emphasis on energy-related problems.

There are three major programs:

1. The Solar Energy Program, directed at exploiting the inexhaustible energy of the sun.
2. The Conservation, Fossil and Geothermal Energy Program, which focuses on near-term energy technologies.
3. The Technology Applications Program, covering a broad range of problems in the biomedical, environmental, and natural resources areas.

Proposed robotic rover to explore Mars beginning in late 1984. The "intelligent" vehicle would travel at least 100 kilometers on the Martian surface during its year-long mission.



Solar Energy Program

JPL is manager of a 10-year project to develop low-cost solar cell arrays (which convert sunlight to electricity) for the Energy Research and Development Administration (ERDA).

Based on its expertise in developing solar cells and power systems for space use, JPL is guiding a program whose goal is to increase the commercial production of low-cost solar cell arrays for use in the home, in farms, and in factories. Long-range tasks include the development of solar-cell-grade silicon, mass production of silicon sheets, and automated assembly and encapsulation of solar cell arrays.

A solar-assisted gas energy (SAGE) system for water heating has been developed in conjunction with the Southern California Gas Company and is being tested in roof-top installations at two apartment complexes in Southern California. The SAGE Project has resulted in solar systems which provide from 52 to 87 percent of one apartment complex's hot water needs in the first 4 months of operation.

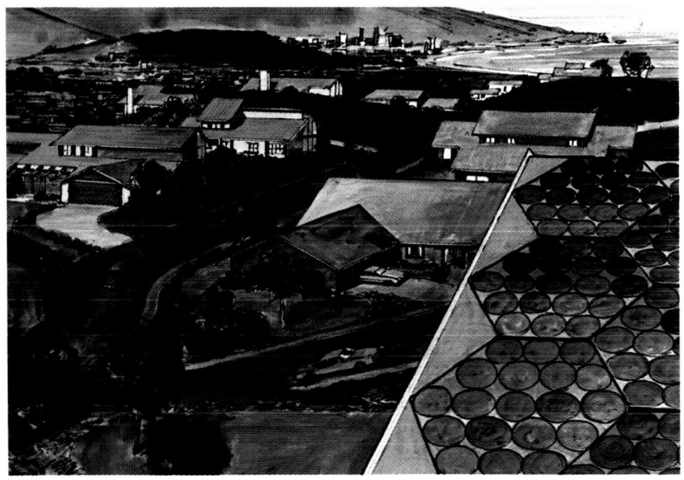
The continuing research includes as cosponsors the National Science Foundation, ERDA, and the Federal Energy Administration.

Conservation, Fossil and Geothermal Energy Program

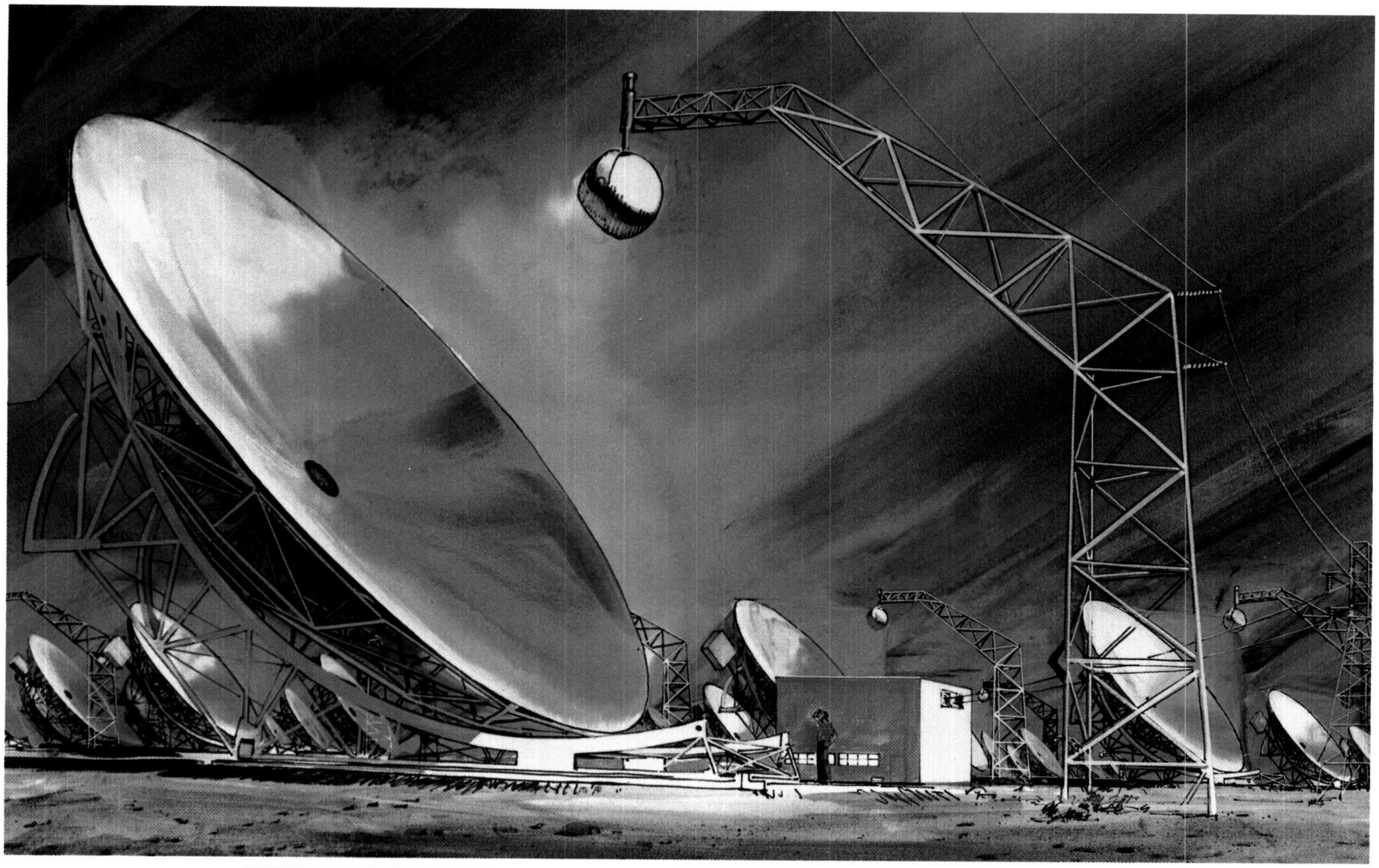
In the Transportation Energy Conservation area, JPL has performed definitive studies for the automotive industry and various federal agencies. The most far-reaching was an evaluation of alternative automotive power plants — including electric ones — for the 1980s conducted for the Ford Motor Company. JPL is also performing design studies, development, and testing of internal combustion engine improvements and of advanced engine concepts, such as the Stirling.

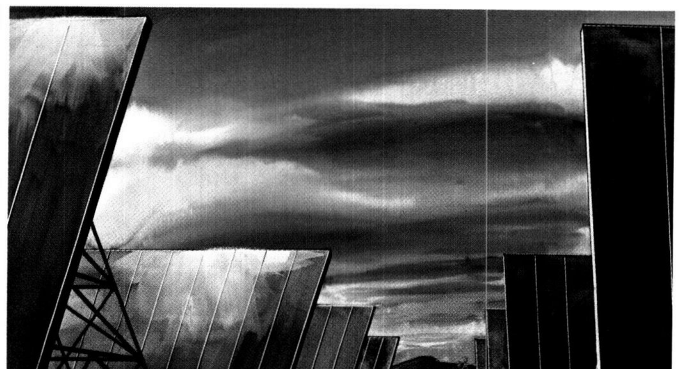
The Laboratory has performed studies to aid the Bureau of Mines and improve the technology of mining coal, which will ultimately lead to advanced coal mining system concepts. For ERDA, JPL is conducting research and development activities in coal handling and coal sulfur-removal techniques.

After an exhaustive geothermal study for ERDA, which identified the potential of liquid geothermal pools, JPL is conducting tests of a new design for a geothermal liquid-resource power system. This sytem would generate electricity by drawing hot brine from geothermal pools under the Imperial Valley desert near El Centro, California. The geothermal power system has been installed at a Bureau of Reclamation test well, prior to pilot plant evaluation.



Top: Rooftop installation of collector panels uses solar energy to heat water and heat and air-condition buildings. Bottom: Photovoltaic panels that convert solar energy to electricity. Opposite, top: Series of large solar collectors, each of which focuses sunlight to drive an engine or turbine, which in turn generates electricity. Center: Facility using solar energy for food processing. Right: Solar farm — acres of solar arrays converting the sun's energy to electricity to be fed into a power grid. Bottom: Solar energy collector drives agricultural irrigation system.





Top: Orange County sewage treatment pilot plant. Bottom: Ocean-bottom explorer vehicle will perform undersea investigations and prospect for oil and minerals.

Technology Applications Program

Among numerous research projects, the JPL Biomedical Technology Program has developed an X-ray dosimeter controller in collaboration with Huntington Memorial Hospital, Pasadena. Utilizing space-developed silicon solar cells, the device automatically ensures correct film exposure to X-rays, reducing the average dosage of X-rays.

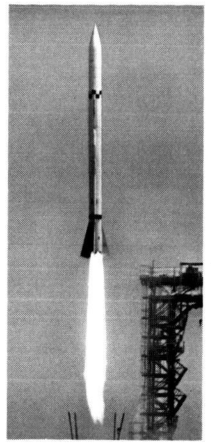
A million-gallon-per-day pilot plant for sewage treatment has been built by the Orange County Sanitation District, using an activated carbon system devised by JPL engineers. Solid waste is converted to activated carbon for use in filtering the water. JPL was system consultant and has participated in the design, construction, and operation of the pilot plant, which is funded by the Environmental Protection Agency.

Land-use studies made for the City of Los Angeles; Orange County; the City of Tacoma, Washington; Pierce County, Washington; and New Orleans, Louisiana, have resulted in a series of computer programs to aid city and county planners. Existing aerial photographs will be augmented by LANDSAT photographs for future studies.

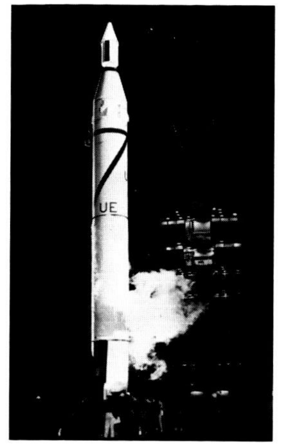
Technology for an unmanned ocean-bottom explorer vehicle has been devised for scientific investigations and prospecting for oil and minerals under the sea. With initial cooperation from the U.S. Geological Survey and the Scripps Institute of Oceanography, the Unmanned Deep Ocean Survey System is designed to employ a remote-controlled, small submersible vehicle capable of exploring to depths of several kilometers.

JPL Missions: 1941-1975

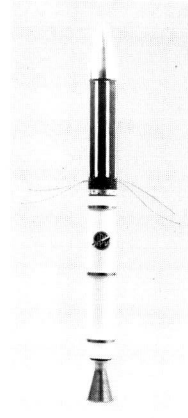

1941 — Jet-assisted takeoff (JATO)

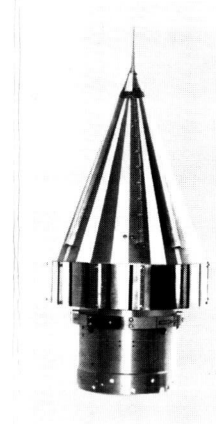

1949 — Corporal, first US ballistic guided missile

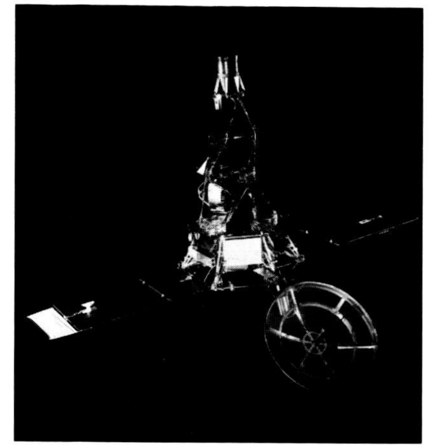

1955 — Sergeant, first solid propellant guided missile

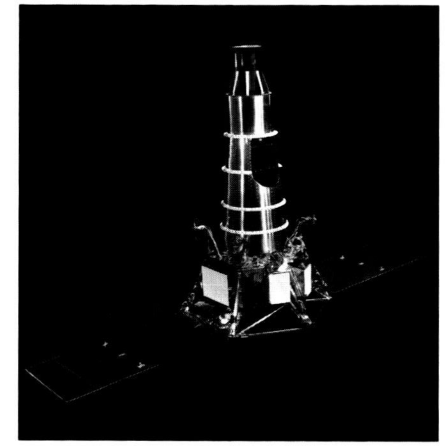
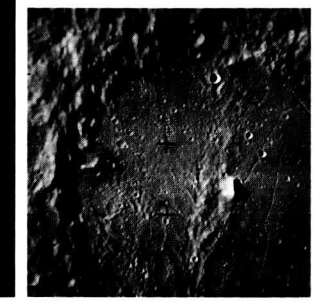


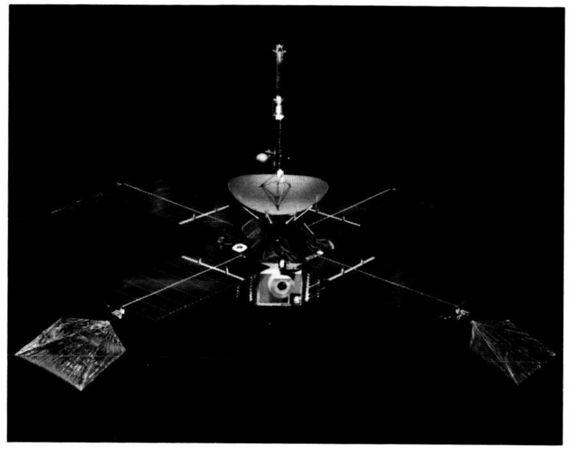
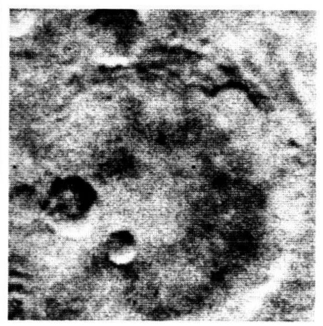
1956 — Jupiter C, re-entry test vehicle

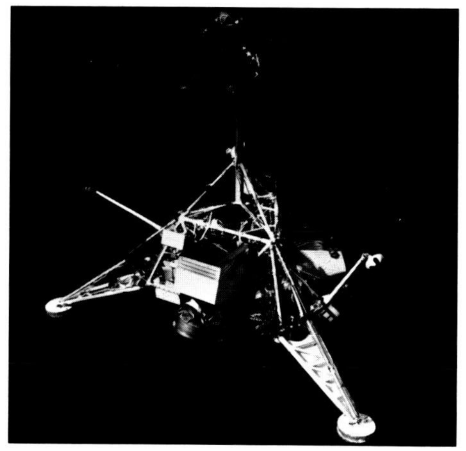
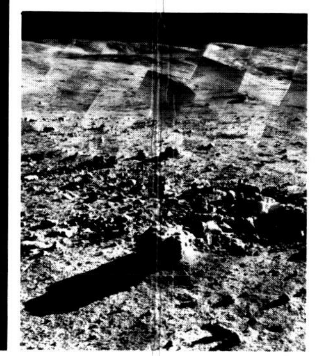

1958 — Explorer 1, America's first satellite

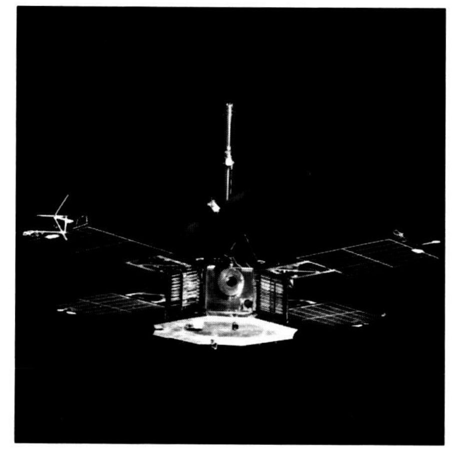

1959 — Pioneer 4, first US deep space probe

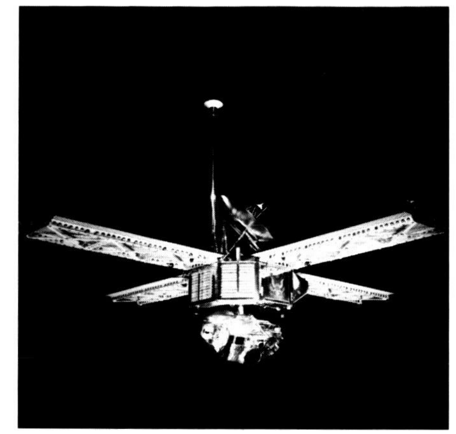

1962 — Mariner 2, Venus flyby



1964-65 — Rangers 7-9, closeup photographs of the moon: The crater Alphonsus

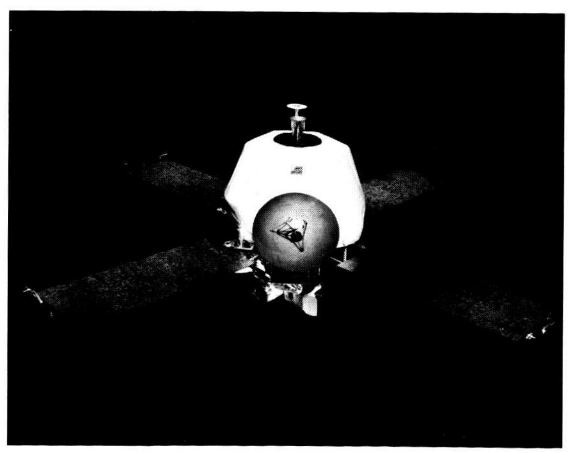
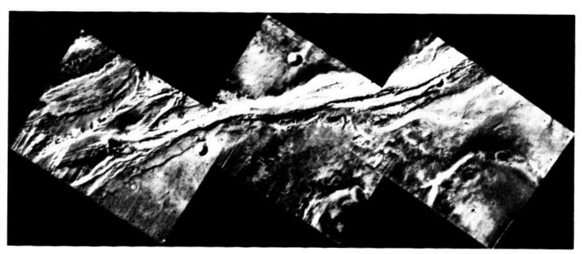


1965 — Mariner 4, photographic mission to Mars: Cratered Martian surface

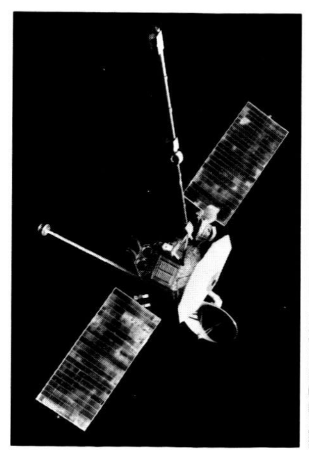


1966-68 — Surveyors I-VII, lunar soft landings: Rocky lunar terrain


1967 — Mariner 5, second Venus flight

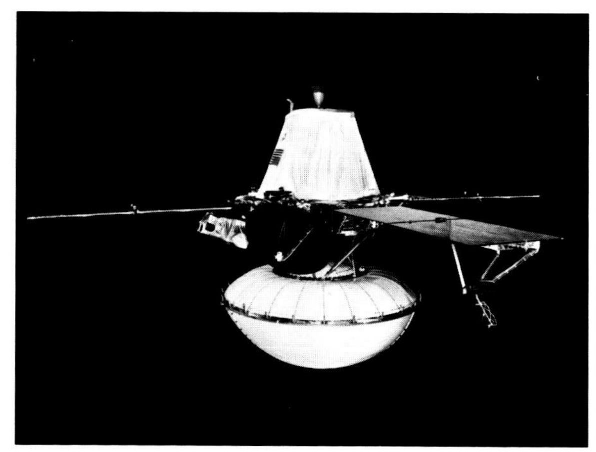


1969 — Mariners 6 and 7, dual Mars mission: "Giant's Footprint"



1971 — Mariner 9, first man-made object to orbit another planet: Mosaic of Martian braid-flow channel



1973 — Mariner 10, photographic mission to Venus and Mercury: Mercury's northern limb



1975 — Viking, Mars orbiter and lander: Valles Marineris, Mars' huge equatorial canyon system